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MORPHOLOGICAL AND ANATOMICAL INVESTIGATION OF SOME ENDEMIC *ALKANNA* SPECIES

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Abstract

The aim of this study is to provide information on the morphological and anatomical properties of *Alkanna froedinii* Rech.fil and *Alkana cardifolia* C. Koch, which are endemic in Turkey and are used in folk medicine. It has been reported that *A. froedinii* and *A. cardiofolia* are closely related to each other. In this study, the *Alkanna* species have been investigated for morphological and anatomical differences. It has been observed *A.froedinii* has some different characteristics from *A. cardiofolia* such as numerous setiform and glandular hairs.

Introduction

Alkanna has 40 species and is found in the Mediterranean region (Seçmen *et al*., 1995). In Turkey, it is represented by 31 species of which *A. froedinii* and *A. cardifolia* are endemic species (Davis, 1978). Many of the of *Alkanna* species have economical and medical importance.Some of them are used in the preparation of drugs for the treatment of abscess and constipation, some of them are used as emanagog and dye, some of them are used to color and identifity oils (Baytop, 1984; Kandemir & Beyazoğlu, 2002). In addition the dye exists in plants roots and is used in food industry (Karamanoğlu, 1973; Zeybek & Zeybek, 1994; Baytop, 1996). The present report gives an account of morphological and anatomical studies on *A. cardifolia* and *A. froedinii*.

Material and Methods

Plant samples were collected from natural populations during its flowering period *A. froedinii*: B7, B8 Elazığ; Bitlis; Hizan Yolbilen district, 2300 m, 02.06.1998 (Altan, 2988). *A. cardiofolia*: B7 Erzurum; Hasankale, Nenehatun district, 1900m, 16.06.1996 (Altan 6407).

Specimens were preserved in the Herbarium of the Faculty of Art and Science, University of Celal Bayar, Manisa, Turkey. The distribution of the plant, according to the herbarium records and Flora of Turkey (Davis, 1978) is shown Fig. 1. The plant samples stored in 70 % alcohol were used for the anatomical studies. The paraffin method was used for preparing a cross section of root, stem and leaves (Algan, 1981). Transverse sections, 15-20 µm were made using a sliding microtome and stained with Safranin- Fast Green.

Results

Morphological Properties

***Alkanna froedinii*:** The plant is 20-45cm tall and is covered by numerous aglandular hairs. This hair gives gray-white color to stem. The root of the taxon taproot in shape. Pale-brown hard bark is present on the root. The stem is erect and 10-35 cm tall. Basal

leaves are linear- lanceolate with entire margins, 6 - 20 × 0.7-2 cm. Cauline leaves are lanceolate to elliptic, 2-7 × 0.7-1.5 cm. Inflorescence is cymes, flowers are actinomorphic symmetric. Pedicel 2-5 mm in length. Calyx 7-13 mm in flower. It has numerous setiform hairs. Bracts are lanceolate to ovate, 1-6 × 0.5-2.5 cm. Corolla 8-18mm in length in yellow colour. Species is distributed at the 1000-2500m height in fields, rocky slopes, steppe and Quercus scrub (Figs. 2, 4).

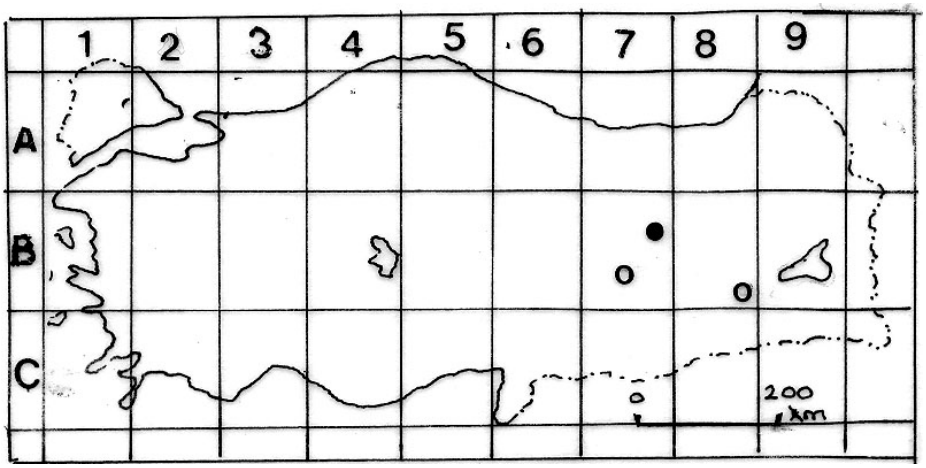

Fig. 1. The locality for which plant samples were collected in small areas of Turkey
° *Alkanna froedinii* Rech. fil • *Alkanna cardiofolia* C. Koch

Fig. 2. General appearance of *Alkanna froedinii* Rech. fil.

Fig. 3. General appearance of *Alkanna cardifolia* C. Koch.

***Alkanna cardifolia*:** The plant is 15-30 cm in length. It is covered by aglandular hairs or with sparse minute glandular hairs. The aglandular hairs are longer than glandular hairs. These aglandular hairs are weak and scarcely setiform.Basal leaves are linear-lanceolate with flat, entire margins. 3.5-12 × 0.3-1.6 cm. Cauline leaves are lanceolate to ovate, 2-6 × 1-2 cm. Inflorescence cymes, flowers are actinomorphic symmetric. Pedicel 1.5-4 mm in length. Calyx 6-14mm in flower. It is covered with lax hairs. Bracts are lanceolate to ovate, 1-4 × 0.3-2 cm. Corolla yellow 9-15mm. Species is distributed at the 500-2000m height, dry stony places (Figs. 3, 5).

Anatomical properties

Alkanna froedinii

Root: The outer surface of root is covered by 4-6 layered periderm cells which are dark colored, crushed, break up and sometimes fall out. Cortex is 6-8 layered. Its cells are flat-ovoidal in shape. The phloem elements are located in small region of root. Cambium cells are 1-2 layered between phloem and xylem. Xylem has trachea cells different in size. The pith occupies a narrow space and consists of parenchymatic cells (Fig. 6).

Stem: In the upper part of the stem, there is a cuticular layer followed by epidermis. Epidermal cells 2-3 layered, 1-3 layered periderm is present under epidermis. Parenchymatical cortex cells are 5-6 layered which are bigger on the centre part than other parts. There are sclerenchymatic rings between cortex and vascular bundle region.

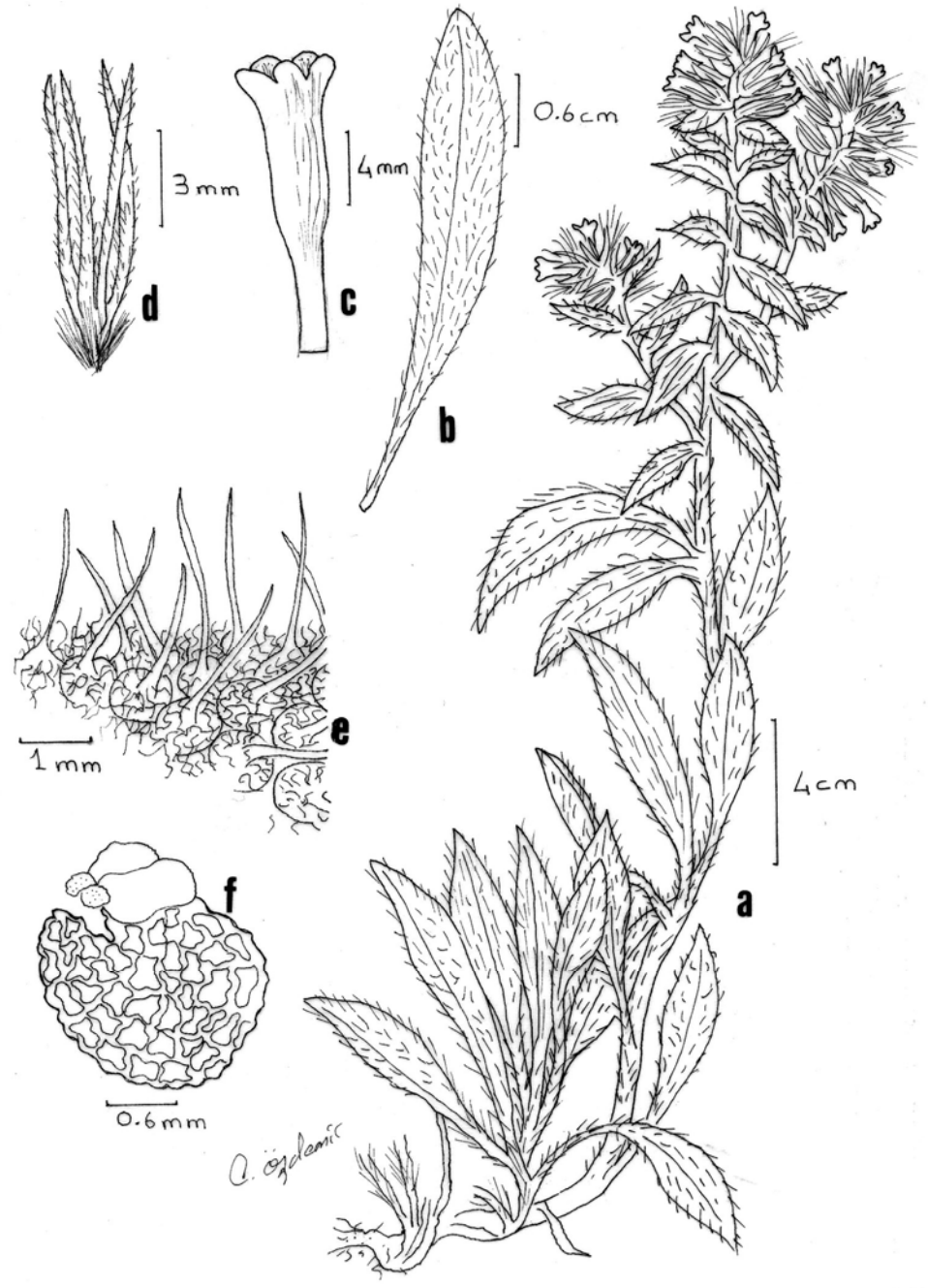

Fig. 4. General appearance of *Alkanna froedinii* Rech. fil.
a- General view of plant, b- Leaf, c- Corolla, d- Calyx, e- Surface of leaf, f- Seed

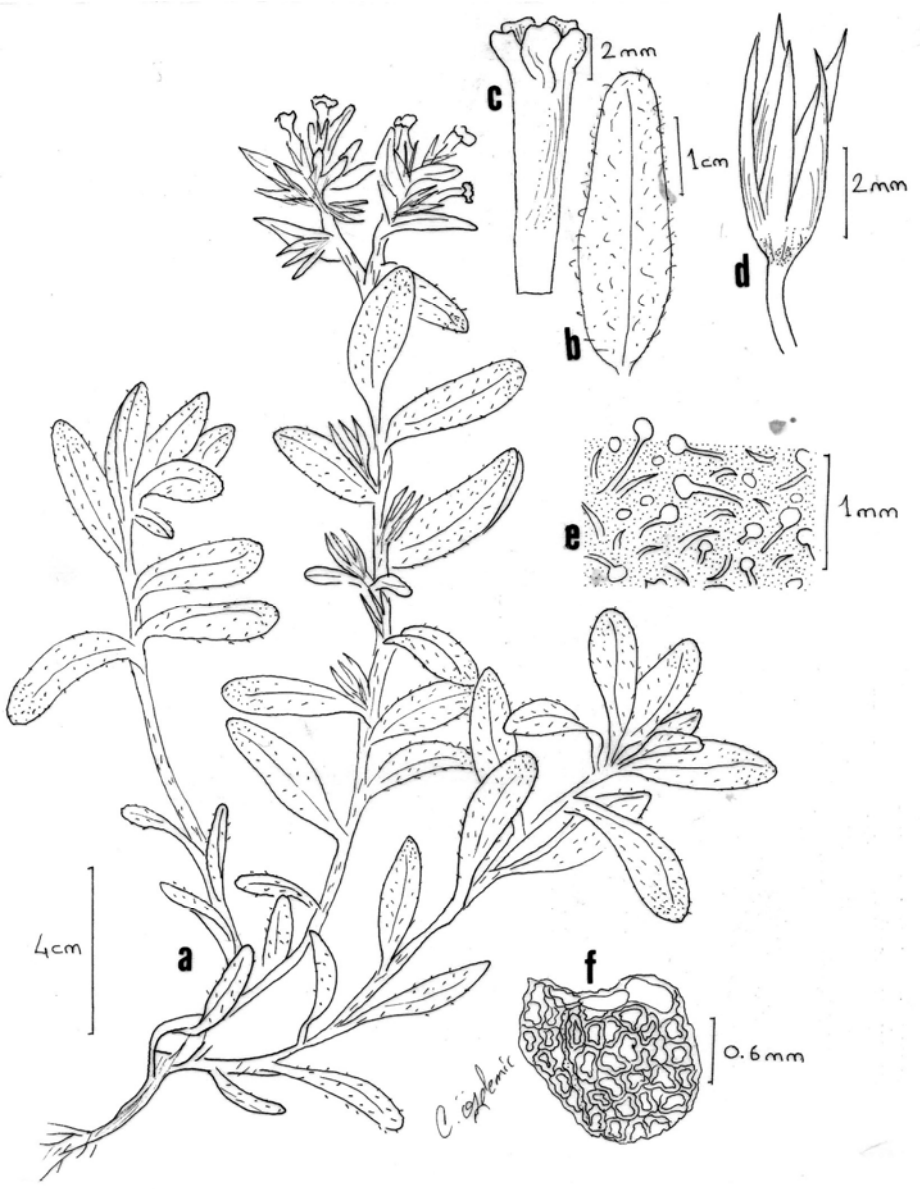

Fig. 5. General appearance of *Alkanna cardifolia* C. Koch.
a- General view of plant, b- leaf, c- Corolla, d- Calyx, e- Surface of leaf, f- Seed

The ring is sometimes crashed.Phloem occupies a narrow space. There are collenchyma cells at the corner of stem. Cambium cells are distinguishable. Xylem elements are located in large region of stem. The cells of pith are flattered and sometimes crashed. Glandular and aglandular hairs are present or epidermis of stem. Glandular hairs are capitate hairs which has single head cell and 1-2 stalk cells (Figs. 7, 12a).

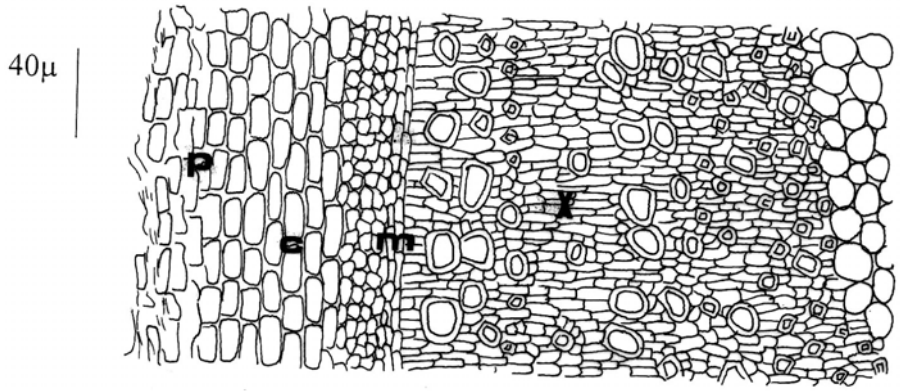

Fig. 6. Cross-sectionof root of *Alkanna froedinii*.
p. Peridermis, c. Cortex, m. Cambium, x. Xylem

Table 1. Measurements of cells of various tissue of *A. froedinii* and b. *A. cardifolia*.

	Alkanna froedinii		*Alkanna cardifolia*	
	Breadth (µ)	**Length** (µ)	**Breadth** (µ)	**Length** (µ)
	min. max.	**min. max.**	**min. max.**	**min. max.**
Root				
Peridermis cell	15-30	10-25	20-30	25-30
Diameter of cortex	25-70	20-35	20-30	10-20
Diameter of trache	30-80		20-45	
Diameter of pith cell	20-80		30-50	10-30
Stem				
Cuticle	5-10		5-10	
Epidermis cell	10-15	10-25	10-25	5-15
Diameter of cortex	20-110		20-10	
Diameter of trache	10-50		15-20	30-100
Diameter of pith cell	50-120	20-40	30-80	
Leaf				
Cuticle	5-10		15-30	
Upper epidermis cell	30-40	15-20	20-30	20-35
Lower epidermis cell	20-40	10-30	15-20	20-30

Leaf: Leaves are bifacial covered by a cuticular layer on both upper and lower surfaces, followed by a single layered epidermis. Lower epidermis cells are bigger than upper epidermis. Palisade cells are rich in chloroplasts. Spongy parenchyma cells occupy a wide area in the mesophyll. There are no broad intercellular spaces in the mesophyll tissue. Aglandular hairs are present on both upper and lower epidermis (Fig. 8, Table 1).

Alkanna cardifolia

Root: Periderm rows are on the outer surface of root. These cells are 2-3 layered and dark colored, sometimes fall out. Cortex is multilayered and parenchymatic. Cell size is larger in primary cortex than secondary cortex. Phloem elements are located in small region of root. Cambium cells are 1-2 layered and distinguishable. The pith is tight and consist of layered parenchymatic cells. The pith has a pith space (Fig. 9).

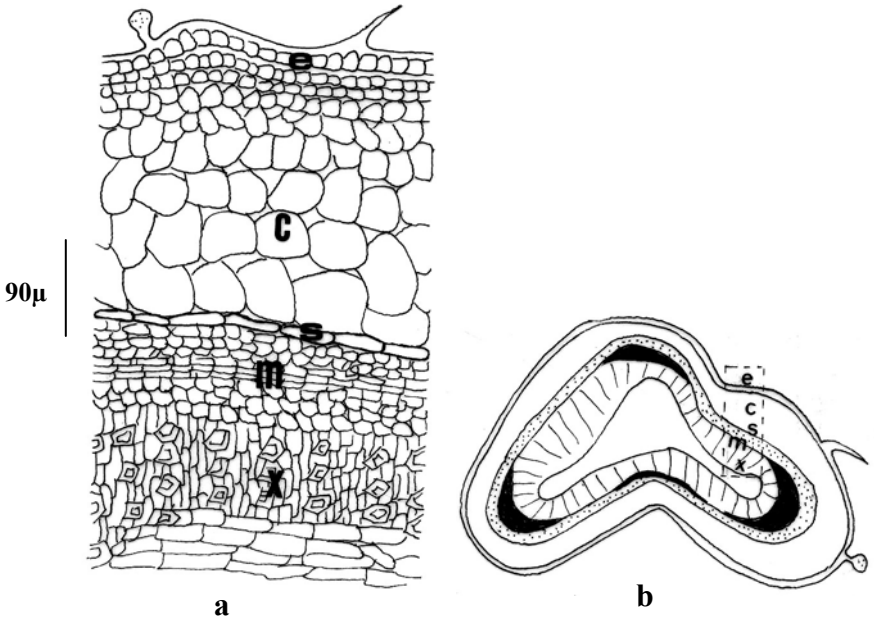

Fig. 7. a. Cross-section of stem of *Alkanna froedinii*.
b. Enlargement of the shown area of a.
e. Epidermis, c. Cortex, s. Scleranchyma, m. Cambium, x. Xylem

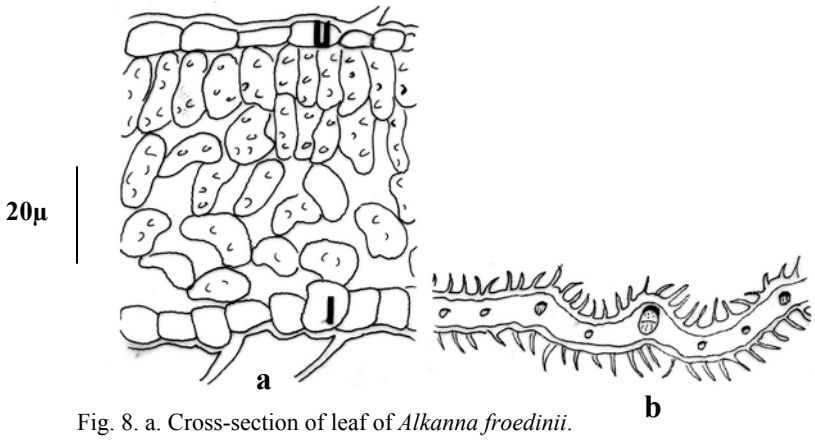

Fig. 8. a. Cross-section of leaf of *Alkanna froedinii*.
b. Enlargement of the shown area of a.
u. Upper epidermis, l. Lower epidermis

Stem: There is a cuticular layer on epidermis. Epidermis is single layered and consist of flat ovoidal cell. Periderm is present under epidermis. Periderm is 3-5 layered. There are cortex cells under periderm. These cells are 4-5 layered and ovoidal. There are sclerenchymatic rings on the phloem. Phloem occupies a narrow space. Cambium is 1-2 layered and sometimes crashed Diameter of tracheal elements are too large. There are sclerenchymatic groups on the xylem.The pith cells are flat-ovoidal. Capitate glandular and aglandular hairs are present on epidermis (Figs. 10, 12 b).

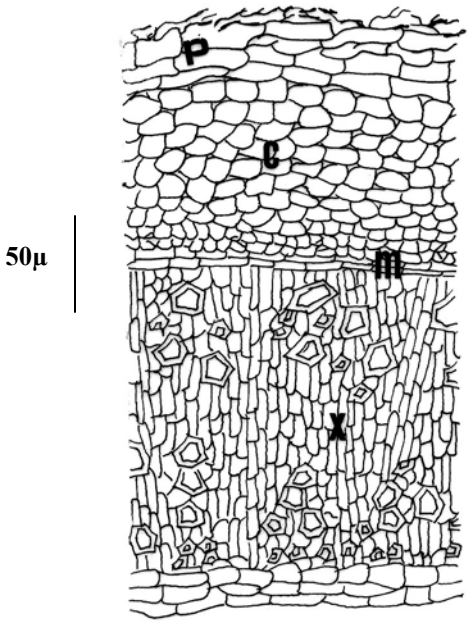

Fig. 9. Cross-sectionof root of *Alkanna cardifolia*.
p. Peridermis, c. Cortex, m. Cambium, x. Xylem

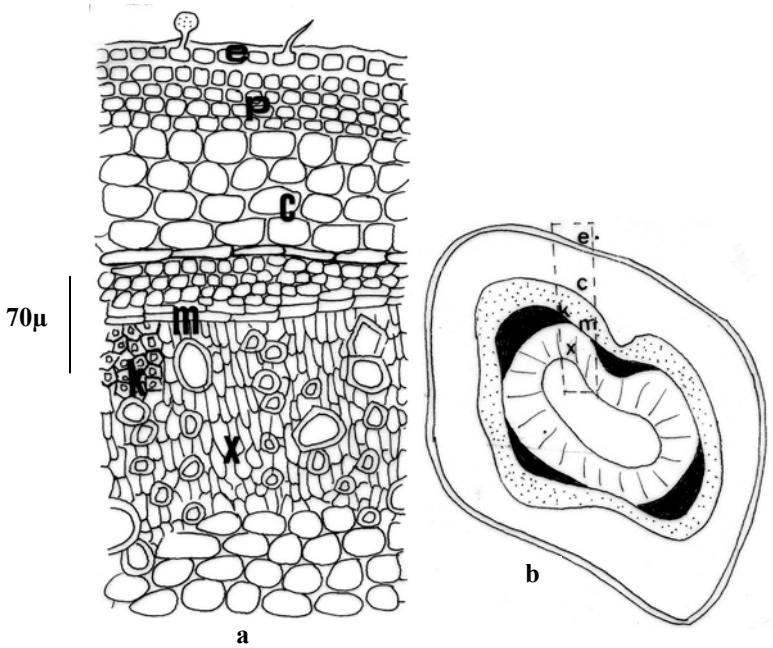

Fig. 10. a. Cross-section of stem of *Alkanna cardifolia*.
b. Enlargement of the shown area of a.
e. Epidermis, p. Peridermis, c. Cortex, m. Cambium, k. Scleranchyma, x. Xylem

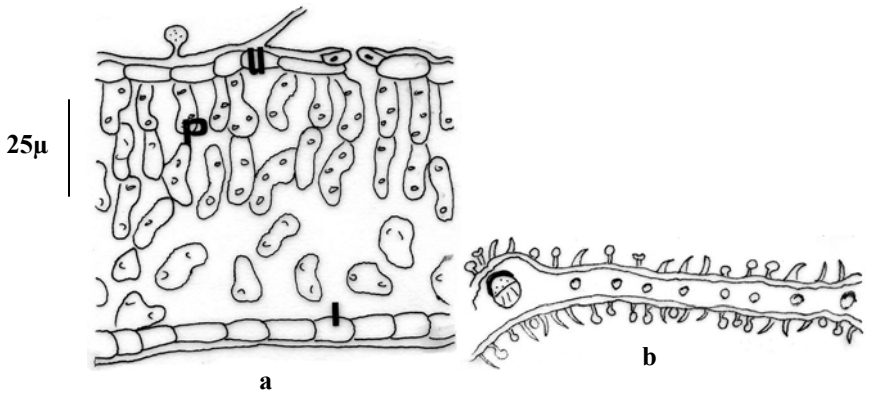

Fig. 11. a. Cross-section of leaf of *Alkanna cardifolia*.
b. Enlargement of the shown area of a.
u. Upper epidermis, l. Lower epidermis

Leaf: There is cuticle layer on both upper and lower surfaces. Glandular and aglandular hairs are present on both upper and lower epidermis having flat- ovoidal cells on upper and lower surface of leaf. Palisade parenchyma cells are 2-3 layered. There are broad intercellular spaces in the mesophyll tissue. Stoma cells are present in both upper and lower epidermis. Glandular hairs are capitate hairs which have single head cells. Furthermore, there are capitate glandular hairs which have cup-like head cell (Figs. 11, 12b).

Dıscussıon

This is the first study on *Alkanna froedinii* and *Alkanna cardifolia* except the description in Flora of Turkey (Davis, 1978). In this study, we have tried to demonstrate the characteristics of the two species evaluating the results obtained from morphological, anatomical investigations. It has been reported that *A. froedinii* is related to *A. cardifolia* (Davis, 1978). Differences have been determined comparing the results obtained from these species. These two species are separable from each other with some morphological and anatomical properties. *A. froedinii* has some different characteristics from *A. cardifolia* such as basal leaves with entire margins, densely covered leaves and calyx with long setiform hairs.

The samples of *A. froedinii* and *A. cardifolia*, used in this study show some differences from findings of Davis (1978). Our samples of *A. froedinii* were 10-35 cm tall, cauline leaves 2-7 x 0.7-1.5 cm and corolla 8-18 mm. According to Davis (1978), the plants are 20-45 cm tall, cauline leaves are 4-8x1-2 cm tall and corolla is 10-20 mm. In our study, we observed that the samples of *A. cardifolia* are up to 40 cm tall and corolla 9-15 mm. According to Davis (1978), the plants are up tu 30 cm tall and corolla 8-13 mm. As a result of morphological studies according to Davis (1978) and our data, it appears that the gradient of variation has widened for endemic *A. froedinii* and *A. cardifolia*.

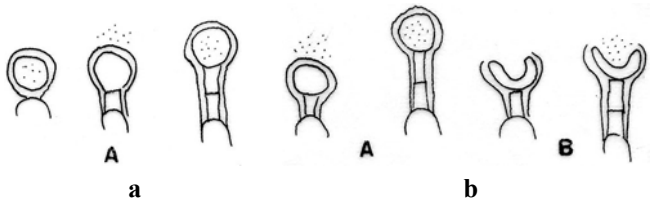

Fig. 12. Glandular hairs different parts of a. *A. froedinii* and b. *A. cardifolia*
(A: type I capitate hair B: type III capitate hair)

The studies of anatomy however, did not show a clear separation between of the two species it has been observed that pith cells of root of *A. froedinii* are ovoidal in shape but pith cells of root of *A. cardifolia* are prismatical in shape. On the other hand, pith cells of stem of *A. froedinii* are prismatical in shape, while those of stem of *A. cardifolia* are ovoidal in shape. In addition, the stem of *A. cardifolia* has bigger trache cells than the stem of *A. froedinii*. It has been determined that there was a sclerenchymatical group and ring over phloem of both of the two species. Özörgücü *et al*., (1991) gave an information about general anatomical characteristics of *Boraginaceae*. The family to which the investigated species belong has stem with deeply and superficial periderm. In this study, it was observed that the investigated species had those properties.

The species were compared by studying glandular hairs on their vegetative and reproductive organs. It has been found out in these observations that *A. cardifolia* has more variable glandular hairs than *A. froedinii* (Figs. 12 a, b). Classification of glandular hairs of the species investigated was done according to Werker *et al*., (1985). Type I and Type III capitate glandular hairs have been observed in *A. cardifolia*. These glandular hairs consist of both one and two stalk cells. The type I capitate glandular hairs which have a head 1 celled and a stalk 1-2 celled have been observed in *A. froedinii*. In addition, stalk cells are not present at some glandular hairs in the investigated species.

In this study, some morphological and anatomical features, such as glandular and eglandular characters, shape of pith cells of stem are distinguishing features for the investigated *Alkanna* species.

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